PSYCHOSOCIAL AND ENVIRONMENTAL INFLUENCES ON "SICK" BUILDING SYNDROME

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"A physical symptom is a perception, feeling, or even belief about the state of our body."
(J. Pennebaker, *The psychology of physical symptoms*, 1982)

"(In the foundry)...they tipped the ladles to pour, white-hot metal splashed like pancake batter and sparks flew through the air.
'Do they do that job all day?' Robyn asked.
'All day, every day.' (Wilcox replied).
'It must be frightfully hot work.'
'Not so bad in winter. But in summer...the temperature can go up to a hundred and twenty Farenheit down there.'
'Surely they could refuse to work in conditions like that?'
'They could. The office staff start whingeing if it gets above eighty. But those two are men.' Wilcox gave this noun a solemn emphasis.
(D. Lodge, *Nice work*, 1989)

"A person who is aware of a given symptom may either not report it or may overreport it, depending on potential reinforcement or punishment from others."
(J. Pennebaker, *The psychology of physical symptoms*, 1982)

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SICK BUILDING SYNDROME

Researchers categorize indoor air quality (IAQ) problems in buildings in a variety of ways. Generally, IAQ problems are divided into those of "Building Related Illness" (BRI) and those of "Sick Building Syndrome" (SBS). BRI describes incidents where workers have been exposed to known contaminants in indoor air (e.g. exposure to bioaerosols from contaminated humidifiers causing humidifier fever, or to airborne bacterial infections such as legionnaire's disease). In BRI incidents a minority of workers usually are affected and show objective clinical signs of illness. Remedial action involves both treatment of cases (affected workers), and removal and control of the contaminant source (Bardana, Montanaro and O'Hollaren, 1988).

SBS is different. Cases typically show no clinical signs of illness; symptoms are vague; symptom prevalence is high (e.g. up to 80% of workers may report one or more symptoms), and complaints are chronic (Wilson and Hedge, 1987). SBS symptoms, as defined by the World Health Organization (1983), describes a general malaise which include symptoms of headache, lethargy, irritated nose and throat, eye problems, skin irritation (see Figure 1). Most SBS symptoms cannot be objectively measured, and there is high variability in symptoms among cases. SBS symptoms are thought to be associated with building occupancy because they often get better when the affected worker leaves the building. SBS symptoms are not thought to be life threatening.

SBS symptoms

Frequent ↑

Lethargy, tiredness, fatigue
Headache
Eye, nose, throat irritation
Cold/flu-like symptoms
Respiratory problems
Nausea, weakness, dizziness
Skin problems

↓ Infrequent

Figure 1 SBS symptoms defined by the W.H.O. (1983)

Buildings with a high prevalence of SBS cases often are called "sick" buildings, although again there is no consensus on how to gauge prevalence and what the criteria should be to discriminate between "sick" and "healthy" buildings?

The W.H.O. suggest distinguishing that "sick" buildings may fall into two categories:

temporarily "sick" buildings - where there is an acute outbreak of health problems in either newly constructed or recently remodelled spaces. Symptoms typically dissipate over time (e.g., usually within 6 months symptom reports have ceased). Volatile compounds from building materials and finishes (e.g. paints, furniture, finishes, etc.) are the suspected cause of many of these complaints.

permanently "sick" buildings - where symptoms may persist over many years. Complaints are difficult to resolve because significant concentrations of indoor air pollutants cannot be detected, yet inadequate IAQ is suspected as the cause because symptoms are alleviated when away from the workplace.

Regrettably, the W.H.O. report did not define SBS in terms of the number or pattern of symptoms which might indicate an SBS case, the severity of symptoms, or the frequency of occurrence of symptoms for a case. Their report gave no explicit guidance on how to measure symptoms, over what time period, or even what symptoms should be measured. The W.H.O. did, however, acknowledge the possible role of psychosocial variables in the etiology of the syndrome.

The term "sick building" is now widely used to emotively describe certain places, although there remains no consensus on what constitutes either an SBS case or a "sick building". Despite this precarious research foundation, reports of SBS/IAQ problems have increased dramatically throughout the 1980s. Between 1971 and December 1978, the Hazards Evaluations and Technical Assistance Branch of the U.S. National Institute for Occupational Safety and Health (NIOSH) investigated only 6 buildings in which IAQ problems were suspected, whereas between 1978 and 1988, 523 such investigations were requested (426 of the total investigations were in office buildings). NIOSH suggested that problems generally seemed to be closely associated with energy conservation practices which includes the design, maintenance, and operation of building ventilation systems, and they suggested that inadequate ventilation (i.e. insufficient outdoor air, poor air mixing, poor air distribution, extremes of temperature and/or humidity, and filter maintenance problems), may account for the majority of SBS problems (Seitz, 1989). However, thorough analysis of the cause(s) of symptoms does not seem to have been undertaken there are no follow-up results by which to gauge the success of either their diagnoses or their recommendations.

METHODOLOGICAL ISSUES IN SBS INVESTIGATIONS

Most investigations of SBS use questionnaire surveys of building occupants to gauge the prevalence of symptoms and IAQ complaints. Usually, the questionnaires are self-

administered, although some studies have used interviewer administered instruments (Finnegan et al., 1987). A recent review of a number of the questionnaires used by SBS/IAQ researchers in the U.S.A., Canada, U.K., Denmark, and Finland found great variability in the symptoms under investigation, the timescale, the question wording, and the response scales used (Hedge, 1990). The extent to which this lack of standardization of either instruments or methods is confounding the results of SBS studies and hampering progress in elucidating the etiology of SBS is unknown.

Because most SBS studies use self-report questionnaires or interviews to collect symptom data, the results will be influenced by numerous psychological factors, including a worker's expectations, awareness of somatic symptoms and his or her tendency to attribute these to the environment. Data from poorly designed questionnaires are confounded by problems of recall bias and response scale bias. Recall bias describes those factors which affect the accuracy of our memory for events. In a study of prescribed drug use, Mitchell et al. (1986) showed that recall was significantly higher when patients were given specific drug names in questions rather than asked to name the drugs being used, even though all patients were on similar drug regimes. Response scale bias results from poorly designed response scales. Categorical scales with scale points of "often", "always", "sometimes", etc., present both the participant and researcher with considerable ambiguity (e.g., how often is often?). Apart from a draft ASTM standard which is currently under revision , there is a dearth of adequate guidance on how to design an SBS questionnaire and conduct a survey of SBS complaints in buildings.

PSYCHOSOCIAL INFLUENCES ON SBS REPORTS

Mass psychogenic illness

Mass psychogenic illness (MPI) describes "the collective occurrence of a set of physical symptoms and related beliefs among two or more individuals in the absence of any identifiable pathogen" (Colligan and Murphy, 1982). The dynamics of MPI depend on two process:

contagion - the spread of affect or behavior from person to person in a group, where each case serves as the stimulus to be imitated by others.

convergence - the simultaneous development of common affect or behavior among group members

Contagion and convergence processes often are triggered by an environmental event (e.g.,

a malodor. In the absence of an identifiable cause this trigger facilitates the expression of symptoms which individuals attribute to an environmental cause (e.g., a "mystery bug"). Symptoms of MPI usually include those of headache, nausea, weakness, dizziness, sleepiness, hyperventilation, fainting, and vomiting, and occasionally include a variety of skin disorders and burning sensations in the throat and eyes (Colligan and Murphy, 1982; Olkinoura, 1984; Boxer, 1985, 1990).

MPI symptoms probably are not purely psychogenic in origin, but are the result of interactions between pre-exiting stressful physical environment and work conditions (e.g., poor ventilation, poor lighting, excessive noise, tedious work, poor organizational climate, poor labor-management relations) and predispositions among individuals (e.g., gender, anxiety level), with a triggering event (e.g., malodor) and consequent psychosocial processes (e.g., management response to the perceived threat). The typical sequence of events from studies of MPI incidents is summarized in Figure 2.

Cognitive influences on SBS symptom reports

We do not possess the necessary physiological receptors to sense many indoor environmental variables. Many gases are colorless and odorless, we cannot detect airborne bacteria, we cannot directly see illumination or hear decibels, we cannot detect radiation, etc. We are imperfect devices for assessing physical environmental conditions in a building. Likewise, we are imperfect at sensing our actual bodily status. Because of these limitations, we often choose hypotheses to explain what we believe to be the environmental conditions and our corresponding somatic status. If, for example, we believe that the office ventilation is poor and that the air contains a colorless, odorless, yet noxious pollutant which causes eye irritation, we will likely behave accordingly by selectively monitoring our eye sensations for confirmatory sensory information. We may even rub our eyes more frequently thereby unconsciously creating this information. Such behaviors are quite common. When people are told to think about how itchy their nose is, many will eventually scratch their nose. When people are told to think about insects such as mites and fleas, many will eventually scratch their bodies or complain of sensations of itching skin. When people at concerts hear others coughing in the intermission, they are more likely to feel the urge to cough. When we read about diseases, we often begin to believe that we have the symptoms[1]. And so on.

[1] Studies of medical students have shown that 70% of first-year students believe they have symptoms of diseases being studied (Pennebaker,1982).

Figure 2 Typical sequence of events in MPI incidents (adapted from Olkinoura, 1984)

Generalized Belief
(e.g. belief in presence of contaminant in a building)

↓

Precipitating Event
(e.g. perception of malodor or observation of usual behavior)

↓

Threat
(e.g. fear of pulmonary distress or illness)

↓

Physiological Arousal
(e.g. increased anxiety, agitation, excitement, fear, hyperventilation)

↓

Revised and Self-focussed Belief
(e.g. attribution of current and prior bodily sensations to the building)

↓

Social Contagion
(rapid spread of symptoms, legitimization of symptoms)

In an office, workers usually cannot precisely attribute causality to their symptoms (e.g., if a worker reports a headache s/he decide may have difficulty deciding whether this is caused by the IAQ, the lighting, the use of a VDT, the pressure of work, the noise, etc.).

SBS symptoms are percepts, and reports of these symptoms are affected by the same cognitive processes which influence all other aspects of perception (Pennebaker, 1982). Instructional set influences symptoms reports via its effect on attentional bias. Reports of nasal congestion are significantly affected by whether people are instructed to focus their attention on nasal congestion, which increases their reports of nasal stuffiness, or to focus their attention on free breathing, which decreases reports of nasal congestion under the

same environmental conditions (Pennebaker and Skelton, 1981). Symptom labels like "shortness of breath" convey different meanings to people, some interpret this as meaning slow, labored breathing, while others interpret this as rapid, shallow breathing (Pennebaker, 1982).

Similar processes may also influence our perceptions of indoor climate conditions. For men there is no significant correlation between measured relative humidity and perceptions of dry air, whereas there is a significant correlation between measured relative humidity and perceptions of dry air for women, although this is the reverse of that expected and reports of dryness increases with increasing relative humidity (Göthe et al., 1987).

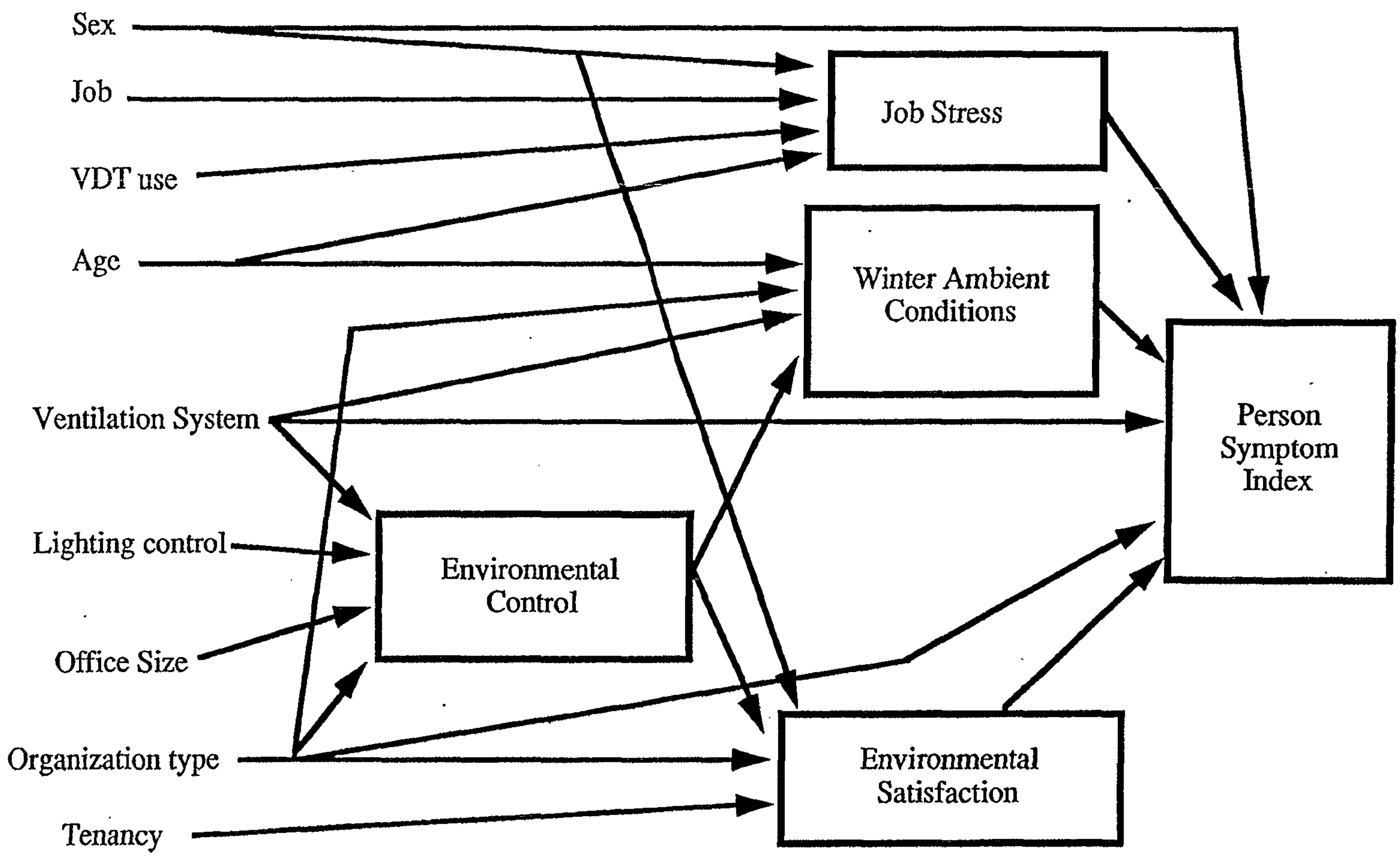
Worker's decisions in describing their symptoms and in attributing causality can be affected by any or all of the above influences, and by other psychological factors (e.g., moods, attitudes, beliefs) known to affect the workings of cognitive processes. Recent research on environmental illness among people with multiple chemical sensitivities suggests that their symptoms also can be explained by one or more commonly recognized psychiatric disorders, such as mood disorders, affective disorders, and anxiety disorders (Black, Rathe, and Goldstein, 1990).

A Model of Environmental Influences on Health in Offices

Hedge (1989) has attempted to capture something of this multi-factorial perspective in a descriptive model (see Figure 3). This model proposes that IAQ complaints and SBS symptom reports arise from the effects of *direct environmental* variables (e.g. exposure to pollutants), *indirect environmental* variables (e.g. worker's satisfaction with thermal conditions), and *non-environmental* variables (e.g. occupational variables such as job stress, VDT use, and individual variables such as gender, stress reactivity, etc.). It is suggested that, at any time, all of the factors described in this model can interact to change the **total stress load** on a worker, and this may either change the individual's sensitivity to environmental irritants or directly precipitate SBS symptom reports. The model suggests that many decisions about SBS symptoms are affected by discrepancies in how internal and external conditions are interpreted with respect to each other, and how individuals are able to cope with the total stress load.

This model also treats indoor conditions as an environmental subsystem which describes the inter-relationships between environmental services (ventilation system, lighting system) and ambient conditions (IAQ, thermal conditions, noise, and vibration). The environmental subsystem interacts with the building subsystem, which includes the characteristics of the building shell , the materials, furnishings and finishes may off gas pollutants, the office

Figure 4 Path model of sick building syndrome (adapted from Hedge et al., 1989b)



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layout, etc. The building subsystem will also affects workers' perceptions of environmental quality, their patterns of working, and workspace preferences (e.g. many office workers prefer private, enclosed offices to open-plan office layouts). Higher levels of distraction open-plan offices also may be stressful to workers (Dick et al., 1981).

The work subsystem also influences the environmental subsystem, because the activities of office workers directly affect IAQ. Breathing generates carbon dioxide, tobacco smoking releases pollutants and particulates, carbonless copy paper may release volatile organic compounds, laser printers may generate ozone, etc. Work activities will also influence the building subsystem (e.g. meetings in open office areas may be a bothersome noise source for proximate, uninvolved workers).

In conclusion this model suggests that whenever complaints and symptoms cannot be attributed to direct exposure to indoor air pollutants or indoor environmental conditions, symptom reports will be depend on individual discrepancies between perceived external states and the person's perceived internal state.

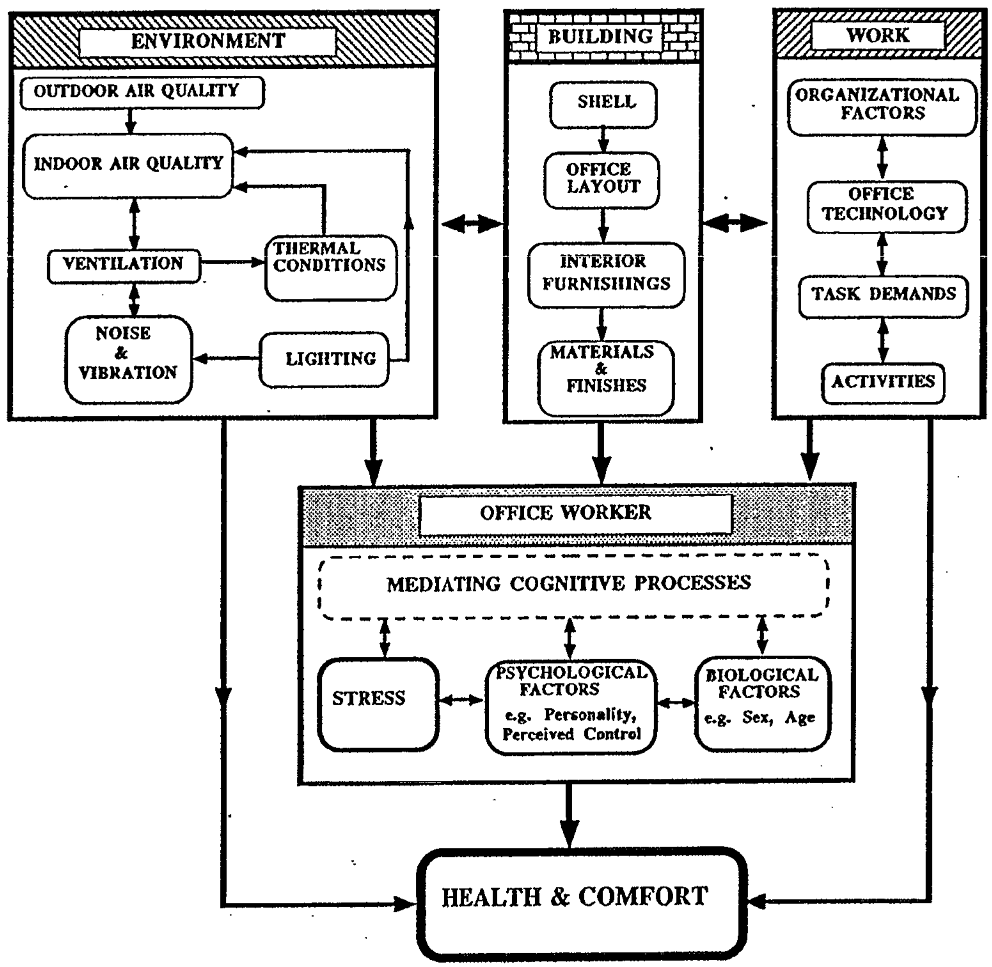
EVIDENCE THAT PERSONAL, PSYCHOLOGICAL, AND OCCUPATIONAL FACTORS AFFECT SBS

Several studies in different countries have found that SBS symptoms are significantly more prevalent in the air-conditioned than naturally ventilated offices (Hedge, 1984; Robertson et al., 1985; Burge et al., 1987; Hedge et al., 1989a,b; Mendell, 1990; Zweers et al., 1990). But apart from this finding there has been comparatively little agreement on the environmental cause of SBS and there is remarkably little research linking SBS symptoms to actual exposures to gaseous indoor air pollutants.

Rather, studies are beginning to give support to the model which has been described and to the usefulness of the concept of total stress load in understanding the etiology of SBS. An investigation of 3 offices found that although workers associated their symptoms with the environmental conditions, there was no correlation between day-to-day fluctuations in temperature and humidity, and reported symptoms of dry nose/nasal congestion. There was, however, a significant relationship between reports of SBS symptoms and levels of stress (Morris and Hawkins, 1987).

A number of studies have shown that SBS symptoms are more prevalent among women than men (Hedge, 1984; Robertson et al., 1985; Burge et al., 1987; Hedge et al., 1989a,b), and why this should be is unknown. There is conflicting evidence that other factors, such as age, atopy and allergy, and smoking status affect SBS symptoms, and

Figure 3 Systems model of the office environment (Hedge, 1989)



whether or not these factors can account for the gender differences.

Occupational factors (job level, hours of computer use, job stress, job satisfaction, handling of carbonless copy paper, photocopying), psychological factors (perceptions of control, perceptions of ambient conditions, perceptions of comfort), and organizational factors (public sector versus. private sector buildings), significantly influence the prevalence of SBS symptoms among office workers (Hedge, 1988; Hedge et al., 1989b; Skov et al., 1989; Hedge, Erickson and Rubin, 1990). A path model describing some of these associations has been tested (see Figure 4).

CONCLUSIONS

The argument advanced in this paper is that the problems of SBS may not be simply a direct consequence of exposure to poor IAQ but rather the results of the combined effects of a variety of environmental and non-environmental factors. It is suggested that, much as we view many diseases as the outcome of multi-factorial processes, SBS might usefully be viewed as the outcome of a set of **multiple risk factors** which act to place a **total stress load** on a person at any time. But as yet we have only a poor grasp of what these factors might be and how they might affect each person.

Regrettably, progress on elucidating the etiology of SBS has been hampered by poor methodology. Many studies of SBS have used poorly designed questionnaires which are either biased, ambiguous, badly scaled, or conceptually ill-conceived. Moreover, questionnaires usually collect data on workers' perceptions of environmental conditions and health over extended periods of time e.g. one month, 3 months, 1 year, whereas measures of environmental conditions seldom are taken over such extensive periods, nor are they normally taken for each individual location in a building. So it is perhaps not surprising that little association between self-reported symptoms and IAQ has been found.

Most studies of SBS have failed to show significant associations between levels of air pollutants and SBS symptoms, but it is possible that a "missing" pollutant or pollutants is responsible for symptoms, and several recent research studies have suggested that the contents of office dust may be the most likely candidate for this missing link (Hodgson and Collopy, 1989; Armstrong, Sheretz, and Llewellyn, 1989; Leinster et al., 1990). However, in all studies which have measured non-environmental variables there is considerable evidence that personal, psychological, and occupational variables also affect reports of SBS problems. Although this remains a neglected area of study, future research should include investigation of at least the variables which have been described.

References

Armstrong, C.W., Sheretz, P.C. and Llewellyn, G.C. (1989) Sick building syndrome traced to excessive total suspended particulates (TSP), IAQ89 The Human Equation: Health and Comfort, pp. 3-7, ASHRAE, Atlanta, Georgia.

Bardana, E.J. Jr., Montanaro, A. and O'Hollaren, M.T. (1988) Building-related illness: a review of available scientific data. Clinical Review of Allergy, 6, 61-89.

Black, D.W., Rathe, A., and Goldstein, R.B. (1990) Environmental illness: a controlled study of 26 subjects with '20th Century Disease', Journal of the American Medical Association, 264, 3166-3170.

Boxer, P.A. (1985) Occupational mass psychogenic illness: history, prevention, and management, Journal of Occupational Medicine, 27, 867-872.

Boxer, P.A. (1990) Indoor air quality: a psychosocial perspective, Journal of Occupational Medicine, 32, 425-428.

Burge, P. S., Hedge, A., Wilson, S., Harris-Bass, J. and A. S. Robertson (1987) Sick building syndrome: A study of 4373 office workers. Annals of Occupational Hygiene, 31, 493-504

Colligan, M.J. and Murphy, L.R. (1982) A review of mass psychogenic illness in work settings. In: M.J. Colligan, J.W. Pennebaker & L.R. Murphy (eds.) Mass Psychogenic Illness: A Social Psychological Analysis, Chap. 3, pp. 33-55, New Jersey: Erlbaum.

Dick, C., Kompart, I., Reinhartz, G., Schnadt, H., and Tossin, N. (1981) Auswirkungen der Tatigkeit in Grossraumburos auf die Gesundheit der Beschaftigten. Pt II. West Germany: Der Bunderminister für Arbeit und Sozialordnung.

Finnegan, M.J. and Pickering, A.C.(1987) Prevalence of symptoms of the sick building syndrome in buildings without expressed dissatisfaction. In B. Siefert, H. Esdon, M. Fischer, H. Ruden and J. Wegner (eds.) Indoor Air '87, Proceedings of the 4th International Conference on Indoor Air Quality and Climate,Berlin (West): Institute for Water, Soil and Air Hygiene, vol. 2, pp.542-546.

Göthe, C.J., Ancker, K., Bjurström, R., Holm, S. and Langworth, S., (1987) Relative humidity, temperature and subjective perception of "dry air". In B. Siefert, H. Esdon, M. Fischer, H. Ruden and J. Wegner (eds.) Indoor Air '87, Proceedings of the 4th International Conference on Indoor Air Quality and Climate, Berlin (West): Institute for Water, Soil and Air Hygiene, vol. 3, pp. 443-447.

Hedge, A. (1984) Suggestive evidence for a relationship between office design and self-reports of ill-health among office workers in the United Kingdom. Journal of Architectural and Planning Research, 1, 163-174.

Hedge, A. (1988) Job stress, job satisfaction, and work-related illness in offices. Proceedings of the 32nd Annual Meeting of the Human Factors Society. (Santa

Monica: Human Factors Society). pp. 777-779.

Hedge, A. (1989) Environmental conditions and health in offices. International Reviews of Ergonomics, 3, 87-110.

Hedge, A. (1990) Questionnaire design guidelines for investigations of "sick" buildings. Indoor Air '90, Proceedings of the 5th International Conference on Indoor Air Quality and Climate, Toronto, Canada, vol. 1, 605-610.

Hedge, A. Sterling, T.D., Sterling, E.M., Collett, C.W., Sterling, D.A. and Nie, V. (1989a) Indoor air quality and health in two office buildings with different ventilation systems. Environment International ,.15, 115-128.

Hedge, A., Burge, P.S., Wilson, A.S. and J. Harris-Bass (1989) Work-related illness in office workers: a proposed model of the sick building syndrome. Environment International, 15, 143-158.

Hedge, A., Erickson, W., and Rubin, G. (1990) The roles of job stress and job satisfaction in the etiology of the sick building syndrome in offices. Paper presented at the APA/NIOSH conference "Work and well-being: an agenda for the 90s", 15-17 November, Washington, D.C.

Hodgson, M.J. and Collopy, P. (1989) Symptoms and the micro-environment in the sick building syndrome: a pilot study. IAQ89 The Human Equation: Health and Comfort, pp. 8-16, ASHRAE, Atlanta, Georgia.

Leinster, P., Raw, G., Thomson, N., Leaman, A. and Whitehead, C. (1990) A modular longitudinal approach to the investigation of sick building syndrome, Proceedings of Indoor Air '90, the 5th International Conference on Indoor Air Quality and Climate, Toronto, Canada, 29 July- 3 August, vol. 1, 287-292.

Mendell, M.J. (1990) Elevated symptom prevalence in air-conditioned office buildings: a reanalysis of epidemic studies from the United Kingdom. Indoor Air '90, Proceedings of the 5th International Conference on Indoor Air Quality and Climate, Toronto, Canada, vol.1, 623-628.

Mitchell, A.A., Cottler, L.B. and Shapiro, S. (1986) Effect of questionnaire design on recall of drug exposure in pregnancy, American Journal of Epidemiology, 123, 670-676.

Morris, L. and Hawkins, L., (1987) The role of stress in the sick building syndrome. In B. Siefert, H. Esdon, M. Fischer, H. Ruden and J. Wegner (eds.) Indoor Air '87, Proceedings of the 4th International Conference on Indoor Air Quality and Climate, Berlin (West): Institute for Water, Soil and Air Hygiene, vol. 2, pp. 566-571.

Olkinuora, M. (1984) Psychogenic epidemics and work, Scandinavian Journal of Work Environment and Health, 10, 501-504.

Pennebaker, J.W. (1982) The Psychology of Physical Symptoms. (New York: Springer-Verlag).

Pennebaker, J.W. and Skelton, J.A. (1981) Selective monitoring of bodily sensations. Journal of Personality and Social Psychology, 41, 213-223.

Robertson, A.S., Burge, P.S., Hedge, A., Sims, J., Gill, F.S., Finnegan, M., Pickering, C.A.C., and Dalton, G. (1985) Comparison of health problems related to work and environment measurements in two office buildings with different ventilation systems. British Medical Journal, 291, 373-376.

Seitz, T.A. (1989) NIOSH indoor air quality investigations: 1971 through 1988. (Cincinnati, Ohio: National Institute for Occupational Safety and Health).

Skov, P., Valbjørn, O., Pederson, B.V., & DISG. (1989) Influence of personal characteristics, job related factors and psychosocial factors on the sick building syndrome, Scandinavian Journal of Work, Environment & Health, U15, 286-296.

Wilson, S. and Hedge, A. (1987) The Office Environment Survey: A Study of Building Sickness, Building Use Studies Ltd., London, U.K.

World Health Organization (1983) Indoor air pollutants: exposure and health effects. EURO Reports and Studies 78, World Health Organization.

Zweers, T., Preller, L., Brunekreef, B., and Boleij, J.S.M. (1990) Relationships between health and indoor climate complaints and building, workplace, job, and personal characteristics. Indoor Air '90, Proceedings of the 5th International Conference on Indoor Air Quality and Climate, Toronto, Canada, vol.1, 495-500.